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QUANTIFIED BODIES IN THE CHECKING LOOP: ANALYZING THE CHOREOGRAPHIES OF BIOMONITORING AND GENERATING BIG DATA

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Abstract: *Biomonitoring digital devices have become popular in physical activities and are receiving intensive focus as motivational and support vehicles for health. The aim of this article is to develop a new theoretical framework to analyze biomonitoring from the two perspectives constituting the opposite ends of the big data spectrum: individual (micro) and institutional (macro). In applying phenomenology of the body, discussions of choreography, and Latour's actor–network theory, I seek to evolve a choreography-based approach that can outline feedback systems between embodied practices and the macrolevel choreography of big data. Health informatics data as economic and political assets are illustrated based on netnography. Netnographic methodology pays close attention to online fieldwork and media texts. Emphasizing the lived body in the analysis of knowledge infrastructure, I aim to contribute to the theoretical discussion of human–data interaction. The findings suggest that highly intimate, personal technology can distance people from their lived bodies.*

Keywords: *biomonitoring, wearable technologies, choreography, phenomenology, embodiment, big data, human–data interaction.*

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INTRODUCTION

The interests of health policymakers and employers have increasingly become involved with self-care interventions, such as healthy diets and physical exercise, to provide health benefits for people and reduce health-care costs. The use of self-monitoring digital equipment in physical exercise, likewise, is becoming increasingly popular and receiving more and more attention as a motivator and support vehicle for self-care and well-being. Self-monitoring, or biomonitoring, refers to tools such as wearable electronic sensors and mobile phones with apps that collect, store, process, and display data about bodily functions. Also known as self-tracking, self-quantification, or the quantified self, biomonitoring has flourished within the domain of health and physical exercise, where a strong demand from competitive sports and biomedical technology resulted in the commercialization of consumer health devices. Compared with a simple pedometer that counts each step and shows the overall figures to its user, the new generation of fitness tracker devices—like the Fitbit, Jawbone Up, and, more recently, Apple's iWatch—are small computers that also can collect, generate, and share data about the physical body. With this information, individuals can manage multiple aspects of their personal health informatics.

The designers of fitness trackers (see, e.g., Medynskiy & Mynatt, 2010) emphasize that biomonitoring is intended to motivate persons to achieve healthy lifestyles. Some fitness trackers are aimed towards full-day activity monitoring, while others focus on single workout monitoring. Users employ biomonitoring technology in different roles within their lives. The design of personal health informatics devices is grounded on the belief that such systems can, through the collection and presentation of personal information, promote individuals' self-awareness and that improved self-awareness consequently leads to self-insight, self-control, and positive, healthy behavioral change (e.g., Khovanskaya, Adams, Baumer, Voida, & Gay, 2013). The quantified self (QS) movement is a network of people whose aim is to promote self-monitoring activities by acquiring data on various aspects of users' physical bodies to improve personal health or professional productivity (Quantified Self Labs, 2015).

By examining biomonitoring through the lens of phenomenology, I propose to rethink self-tracking data production and its rationalities. The fundamental aim of phenomenological philosophy is to develop a greater understanding of individuals' experiences through the consciousness of the experiencer (Giorgi, 2009). The phenomenological approach, as used here, is based on a phenomenological notion of the body, more specifically the distinction between the physical body, or *Körper*, and the lived body, or *Leib* (Husserl, 1954/1970; Leder, 1990, 1998). The primacy of *Körper* has been highlighted in many disciplines, including biomedical technology, and in diverse aspects of sport sciences, physical education, and human–computer interaction (HCI). In the everyday discourse of physical exercise, the body usually concerns *Körper*, a corporeal entity that consists of muscular fibers, complex brainwaves, neural pathways, circulation, and so on. In many popular fitness-training programs, people are expected to modify the *Körper* by building muscle, burning fat and calories, stretching muscles and tendons, and improving cardiovascular functioning.

In trying to provide an alternative to mind–body dualism, phenomenologists (see, e.g., Gallagher & Zahavi, 2012; Parviainen, 2011) outline the third category between body and the mind, the *Leib*, as a conscious, active, reflexive, and embodied entity. Following Husserl's notion of *Leib*, Merleau-Ponty (1945/1962, p. 139) described the lived body, *corps vécu*, as a conscious subject that is never a mere physical thing but has its own intentionality and body awareness. Merleau-Ponty (1945/1962) and Sheets-Johnstone (1999) have stressed that bodily sensations, in particular tactile and kinesthetic sensations, may have clear meanings without overt symbolic (linguistic) value. The sense making of bodily movements does not reside in words but is evoked in the meeting of the spatial and material world and other living beings.

Today's biosensors can provide robust data about physical bodies, such as pulse, step count, blood pressure, and so on. By collecting and processing data based on software, some biosensors also provide verbal or textual signals to users, such as, "exercise harder" or "drink water." However, people can experience a range of vague bodily feelings and sensations that they cannot monitor. For instance, individuals cannot expect to receive a diagnosis of the feeling of resonating with other lived bodies in everyday life, no matter how well the sensors work; making sense of their vague bodily feelings during exercise poses problems that go beyond reading signals from biosensors. The phenomenological approach of this study aims at making sense of how biomonitoring equipment collects physical data from physical bodies but cannot reach lived bodies, the bodily sensations, feelings, kinesthesia, affects, atmospheres, and desires in and between bodies.

However, despite its clear assets as a method, phenomenology sometimes fails to address the social context of lived experiences (Langridge & Ahern, 2003). Furthermore, although phenomenology can help generate structures of lived experiences, it is not suitable for making generalizations about institutional structures (Mayoh & Onwuegbuzie, 2015). As Savat (2013) suggested, technological ensembles now take place on a greater scale than they ever did before. To meet the aims within the broader theoretical framework of HCI, actor–network theory (ANT; e.g., Latour, 1997) and theoretical discussions of choreography (e.g., Schiller & Rubidge, 2014) are brought together to highlight the role of movement in biomonitoring. One of the greatest strengths of phenomenological methodology is its flexibility and adaptability that allow for its incorporation within other disciplines (e.g., Dourish, 2001; Garza, 2007).

Given the rise of social networking and mobile technologies—and the ever-increasing digitalization of leisure and daily actions, including fitness activity—the quantity of personal data being generated today has reached an unprecedented scale. Big data is considered here primarily as a knowledge infrastructure generated through an ensemble of techniques (Ajana, 2015). When a society is becoming data-driven (Pentland, 2013), it is important to make distinctions regarding how personal data are created. Observed data, such as online shopping behavior, are inferred and created from information about individuals collected by programs (Mortier, Haddadi, Henderson, McAuley & Crowcroft, 2015; World Economic Forum, 2011). Data can be intentionally created by individuals through online social network profiles, which is a process called volunteered data. Personal data created by wearables are observed data but people usually provide it through online social network profiles, so it becomes volunteered data.

To describe this data collection and its political and economic implications, an ethno-methodological approach or, being more specific, a "netnographic" approach, was used in this study. As a modification of the term ethnography, netnography refers to online fieldwork that follows from the conception of ethnography as an adaptable method (Kozinets, 2010). The Internet has become an important site for research, so a number of researchers have utilized online communities—including newsgroups, weblogs, forums, and social networking websites—to examine various phenomena. Recent media texts, such as newspaper items, columns, and blogs, are used to illustrate how personal health informatics is collected through sensors and trackers to generate big data.

When individuals are bound through their digital devices to processes in which their personal data are collected, analyzed, and traded, it is necessary to reflect on the feedback mechanism of this system. HCI research has traditionally focused on the interactions between humans and computers-as-artifacts. However, Elmqvist (2011) and Haddadi, Mortier, McAuley and Crowcroft (2013) suggested that it is time to recognize the phenomenon of human–data interaction (HDI). HDI does not concern interaction between humans and computers generally but, rather, between humans and the analysis of large, rich personal datasets. As Haddadi and his fellows (2013, p. 5) stated, “HDI overlaps HCI but is not contained within it.” HDI concerns people interacting with an apparently mundane knowledge infrastructure that they do not necessarily recognize or understand or would rather ignore. Opening up such infrastructure and its dynamics is a challenge because the scale of these systems is much bigger than usually considered in interactional studies.

To understand the dynamism of how information is generated, two perspectives are important: the individual (micro) and the infrastructural or institutional (macro). As Klauser and Albrechtstlund (2014) suggested, these constitute the opposite ends of the big data spectrum. These opposites are not combined in an arbitrary manner but include complex feedback systems. In the endeavor to study the intimacy inherent in everyday use of wearable computers combined with big data development, the notion of choreography, Latour’s notion of ANT, and the phenomenology of the body help to develop a coherent theoretical framework. The notion of choreography and its related concepts, such as kinesthesia and kinesphere, assist in capturing an intimate integration of everyday use of wearable sensors and lived bodies.

In this paper, my aim is to develop a new choreography-based theoretical framework to analyze biomonitoring on a larger scale, instead of as a mere personal activity. The notion of HDI (Haddadi et al., 2013) assists discussions of human–technology choreographies to consider what kind of feedback systems link the microlevel choreographies of personal biomonitoring to the macrolevel choreography of collecting big data. This paper begins, firstly, with how the processes of collecting personal data as health informatics are illustrated based on a netnographic methodology. Secondly, choreography as a theoretical framework is introduced to show how it assists in analyzing biomonitoring in everyday life. Next, particular attention has been focused on the phenomenological view of embodiment to show why individuals cannot reach the lived body through fitness trackers. After, my aim is to outline how a “checking loop,” such as a microlevel choreography, has become normalized as an embodied practice in the context of fitness and well-being. The paper concludes by discussing feedback systems that turn the macrolevel choreography of generating big data back toward citizens and consumers to establish new types of embodied disciplines and health care policies.

BIOMONITORING AND PERSONAL HEALTH INFORMATICS

Personal health informatics data, which have emerged only in recent years, represent an entirely new class of data. They refer to self-collected intimate data about one’s own health and health-related activities, often obtained autonomously from smartphones, activity trackers, wearable devices, and other sensors. Self-tracking applications can collect all kinds of everyday activities, thoughts, and statuses into discrete data that can be stored, analyzed, and used to guide to positive outcomes. They are quantifiable, analytical data about health, habits, and routines, from the temperature in a particular sleep environment to the exact amount of time people have been still, sitting in a chair (e.g., Li, Dey, & Forlizzi, 2011; Thomaz, 2013). An increasing number of people are carrying smartphones and devices with them all day, every day, and these devices can be used to collect data.

Most modern smartphones have a plethora of sensors built into them and many of these have self-tracking applications. Smartphones are primarily telephony devices, but the inclusion of multiple sensors along with a suitable app execution environment can turn them into general purpose, self-tracking devices. The sensors of smartphones may include an accelerometer, gyroscope, barometer, heart rate sensor, thermometer, proximity meter, and navigation systems (Barcena, Wueest, & Lau, 2014). Apps also assist users in collecting data from the physical body that sensors currently cannot capture, such as data on moods, food and drink consumption, aches and pains, and so on. In addition to smart phones, fitness trackers like Fitbit, Jawbone UP, and Lullaby sense many types of human activities and dissect these activities into quantified measures, such as the number of hours in REM sleep.

In monitoring physiological measurements, such as pulse, respiration, and blood pressure in terms of fitness activities, fitness trackers do not just give feedback to the mover, but they also can allow data to be collected and processed based on proprietary software and algorithms. Wearable devices typically have a small and light form factor, letting users wear them on the wrist like a wristband or as a watch. Alternatively, they can be attached to sports equipment such as running shoes, clothes, bikes, and more. These devices usually contain accelerometers and gyroscopic sensors that are responsible for generating the data. Barcena and his fellows (2014, p. 12) stated that, “By reading the stream of data from these sensors and then applying data processing algorithms, the devices can recognize patterns to identify the wearer’s current activity.” To indicate how many calories the user has burned, for example, a tracker needs to access data on the user’s age, gender, height, and weight and add them to data about the user’s heart rate, estimation of perspiration, and how many steps have been taken, and then ultimately process all this data to generate the single measure based on its algorithm. To translate the raw data into actual figures and statistics on their screens, fitness trackers use slightly different algorithms.

As Thomaz (2013, p. 3) suggested, before fitness trackers and wearables emerged, “We were not conscious of how many flights of stairs we climbed on a given day or the exact amount of time spent brushing our teeth.” Therefore, from the perspective of phenomenology, it is clear that these systems are actually tracking tacit bodily activities and make these trivial routines more visible in daily life. In fact, biomonitoring quantifies a dimension of physical bodies of which people were not aware and considered as irrelevant information. This stream of data is of interest now because people have collectively understood that these previously ignored quantifiable dimensions implicate their state of health and well-being to the extent that they should attend to them. In effect, data collecting by biosensors constitutes the foundation of many health-related activities and behaviors.

Recently launched fitness tracker devices, such as Apple’s iWatch, are already preparing to play a bigger role in collecting health informatics from their users. Smart fabrics and materials, smaller sensors and processors, and improved battery life within the ubiquitous communications infrastructure have all opened up a new world of possibilities for devices that can be worn and carried around all day. Microsoft and Apple are in competition to develop a smart watch that includes glucose-monitoring technology. Olson (2014, p. 1) pointed out that, glucose monitoring is the holy grail because of the insights that could give into what someone has eaten. That would be a crucial data point for insurers because diet has a far greater impact on health than activity.

Typically, persons who are actively tracking their bodies are sports enthusiasts. Using sensors, keen runners can collect data about their running activity to help them set performance goals and evaluate their progress. Being constantly logged in to their performance data, they can witness their dynamic physical condition and choose a proper technique to improve their results. Moreover, as Barcena and his fellows (2014, p. 6) stated, “There are also self-tracking geeks who are interested in documenting all facets of their daily lives in as much detail as possible in public and have turned the whole idea into an art form.” Aside from enthusiast users, many people may be just curious or wish to achieve a goal, such as losing weight, getting more sleep, or living a generally healthier lifestyle. While the health benefits of use of self-tracking devices and apps cannot be scientifically proven, many people clearly believe they are beneficial for their motivation. Biomonitoring and personal informatics are perceived largely as a positive development because they offer people the opportunity to gain a more refined understanding of their physical body’s condition. Nevertheless, it is still important to remain critical and examine the extent to which the practice might affect their lives.

Self-tracking is already a big business and is expected to grow rapidly. According to PricewaterhouseCooper’s (2014) report, 1 in 5 Americans owns some type of wearable technology. This figure does not include smartphones that can run self-tracking apps that would, if accounted for, amount to billions of units worldwide. According to a study by Fox and Duggan (2013), 69% of Americans regularly track their weight, diet, or exercise activity. One key technology driver behind big data is the potential of the wholesale of personal data (Barcena, et al., 2014). For instance, insurance companies are interested in gaining access to data generated by fitness trackers (Accenture, 2015) because big data would be extremely valuable for risk estimations.

Never before have such huge amounts of health informatics been collected, transmitted, and stored about users. So the question of anonymity of data has become more relevant. The anonymity of data collection can be at risk when data are being sent from one device or location to another. One concern is that users are tracked without knowing other devices nearby are collecting information on them. Although some of the data could be considered highly sensitive, much of the information listed is not. For example, hospitals are required to carefully handle medical data, but data about the amount of water a person drinks daily are not seen as delicate information. Gaining access to personal health data is a potential goldmine for employers because these data can allow them to gain deep insight into their employees. Olson (2014, p. 1) suggested that “more employers are opting to monitor data being generated by fitness trackers—to the extent they can see it on a dashboard—and are holding their insured staff to account with rewards as part of a growing number of so-called corporate-wellness programs.” Employers are exploring ways to monitor their staff's wearable devices to help them reduce health-care costs. As part of corporate wellness programs, employers may offer their employees fitness trackers and, as a service for monitoring this data, they might reward employees for fitness activity. To explore further why personal data are not a mere personal issue, I consider in what kind of theoretical framework biomonitoring can be analyzed on a larger scale without losing touch with its intimate act.

CHOREOGRAPHY AS THEORY

Choreography can be divided into practice and theory. Plenty of guidebooks for dance students and other practitioners present how to make choreographies in practice (e.g., Blom & Chaplin, 1989; Smith-Autard, 1996; Tufnell & Crickmay, 1993). Then there is research literature that develops theoretical and philosophical approaches to choreography, mainly in the contexts of dance cultures and performance (e.g., Kozel, 2007; Lepecki, 2006; Manning, 2009). The line between practice and theory blurs, however, because movement theories usually emerge from practical knowledge and experience, involving a hermeneutic circle between theorizing and practicing. Rudolf Laban was a good example of a choreographer who also developed a movement theory and movement analysis method. Laban's effort–shape (1980) is a widely used method to analyze everyday bodily movements in different contexts, including HCI (e.g., Hummels, Overbeeke, & Klooster, 2007; Loke, Larssen, Robertson, & Edwards, 2007). However, as a movement theory, effort–shape has some limitations in the context of this study. Laban restrained the analysis of movements and gestures in a limited space and time scope so, as a theory of choreography, it is not necessarily the best approach to analyze movements whose scale can reach across the world. In addition, he did not give much weight to nonhuman agents and environments in making movements.

My interest in this paper is to consider movement as a relational net or a reciprocal and dynamic matrix. The choreography is manifested and materialized by bodies, action, and environment rather than simply bodies making movements to create choreography. There is a reasonable amount of theoretical discussion of choreography (e.g., Butterworth & Wildschut, 2009; Foster, 1995; Hunter 2015; Klien, 2007; Parviainen, 2010; Robertson, Lycouris, & Johson, 2007; Schiller & Rubidge, 2014) that can assist in developing a coherent choreographic approach to understanding movement in the context of this study. I wish to (a) consider constellations of movements in which various actors/agents are involved and (b) disrupt notions of inside versus outside the body. In this context, choreography is not seen as belonging to the domain of dance. Rather, choreography refers to movements and activities in which movements appear to form meaningful interactions and relations in a lived space between various animate or inanimate agents. Thus, no choreographer alone could lead the dynamics of this constellation; rather, human and nonhuman agents have connections with each other that establish ongoing choreography. Treating human and nonhuman agents symmetrically here, choreography is seen to arise from their relations that become perceptible through movements, motion, patterns, and rhythms.

This notion of choreography resonates with theories of the actor network (e.g., Latour, 1997; Law, 1992). Latour (1997) and his colleagues (e.g., Law, 1992) suggested that objects can become agents or *actants* with humans, influencing action as well as resulting from it. An assemblage of people, objects, and technologies are composed of heterogeneous elements that enter into relations with one another. When digital technologies, action, and materiality intertwine, human bodies do not remain independent entities from technologies. In this assemblage, embodied connections with digital technologies modify physical and lived bodies, forming new kinds of *embodied practices*. Deborah Lupton (2013, p. 400), alluding to Peter Freund, used the term "technological habitus" to describe how bodies develop new habits and routines to blend in with the function of technologies. She suggested that bodies do not intermesh smoothly or seamlessly within technology but rather there are disjunctions between bodies and objects. Embodied practices do not refer to mere habituation or the domestication of technology but to how new bodily activities are developed to cope with or utilize new technologies. For instance, running as a form of physical activity is not dependent on any high-tech gadgets. But, running with sensors and wearables depends on an assemblage of fitness trackers, apps, and perhaps link stations in the running environment. Although running with wearables mobilizes a new type of assemblage, it also changes the style of running when runners need to check certain numbers and figures on their wristbands to adjust their running speed. In this relational materialism, actants are managed to make new relationships and form new running routines as embodied practices.

Latour's (1997) approach to ANT emphasized agency and an assemblage of actors in which he did not give much concern to experiential aspects of these actants; in other words, how feelings, affects, and sensations influence relations among actants. The choreographic and phenomenological approach is to focus on the quality of action: How does the special quality of actants' movement keep action alive and make things happen? To answer to this question, it is important to rethink the meaning of movement and kinesthesia (e.g., Husserl, 1973/1997; Sheets-Johnstone, 1999) in an assemblage of people, objects, and technologies. It is necessary to consider what kind of role movement and lived bodies have in making affective relationships when pulling and pushing things towards a constellation. This notion of choreography challenges the traditional view of technology as residing in individual cognitive or psychological processes and instead shifts the focus of HCI toward embodied social activities and transitions in a network of heterogeneous elements. This choreographic approach recognizes the importance of the interaction of hardware and software technologies, bodies, and environments brought together in an active relationship and in a particular spatial configuration that can be both planned and improvised.

Kinesthesia plays a central role here in understanding interaction among lived bodies and their interactions within material environments. As a sense of motion, kinesthesia is something that helps researchers recognizes differences and similarities within a person's own movement qualities, haptic sensations, and the moving objects around them. When one lifts an object, this reveals something about the object's weight. Rubbing ones fingers across an object reveals details about the texture and shape of the object. Squeezing an object says something about its compressibility. Thus, bodily movements are fundamentally intentional and mindful in themselves in a way that they have a special kind of reflective thinking (Sheets-Johnstone, 1999). However, in the present study, the dynamics of interaction among bodies reach beyond immanent bodily experiences and kinesthetic limits.

In my previous studies with colleagues (Parviainen, Tuuri, & Pirhonen, 2013), we developed a notion of choreography that can help to evolve a coherent theoretical framework in which the emphasis is on the intimate physical contact of sensors combined with big data generated. We distinguished three scopes of choreography by using the terms micro-, local-, and macro-levels. In a *microlevel* analysis, the focus is on, for instance, the movement of the index finger swiping across the screen. These are the movements that take place within one's kinesphere or internally. *Local-level* choreographies refer to bodies in their social interaction, for instance, when passengers, sitting or standing on the metro, hide behind their phones in trying to avoid eye contact with other people. The *macrolevel* choreography refers to large-scale movements that go beyond human embodied efforts, for instance, to link transporting infrastructures or the Internet to create extensive trajectories. Thus, those passengers on the metro, hiding behind their mobiles, might read text messages from their friends on other continents or watch a video on YouTube that has been seen by over 100 million other people.

Instead of focusing on material objects and singular gestures in using them, this choreographic approach offers a new theory to consider movements as trajectories, transitions, and relations in interaction design. This approach does not restrain the analysis of movements and gestures in a limited space/time scope but takes into account the scale of the three levels of choreography that are usually involved when people use digital devices in everyday life.

Before I consider further the idea of choreography in the context of biomonitoring and fitness trackers, the notion of *innesphere* is introduced to illuminate the difference between the lived body and the physical body.

INNESPHERE AND THE LIVED BODY

Turning back to Laban (1966, p. 10), he created the concept of *kinesphere* that was defined as the “space which can be reached by easily extended limbs.” By kinesphere, Laban referred to bodily movements and activities in an “individual bubble.” Drawing on the sociological discussions of personal space (Moore & Yamamoto, 1988) and the phenomenological notion of subjective space, the concept of kinesphere can be also understood to include affective and social connotations forming lived space. The spatiality that individuals live in and through their bodies and that surrounds them is called lived space, and it plays a central role in local-level choreographies. Phenomenologists (e.g., Husserl, 1973/1997; Merleau-Ponty, 1945/1962) considered that the lived body cannot be treated as a mere material object that locates in the three-dimensional geometric space. In this sense, the notion of lived space differs from the schema of Euclidean three-dimensional space or a mere individual bubble. Objective space can be scrutinized and measured with fixed metrics, and it has become the foundation of the physical sciences and digital technology.

To understand human movement in all its complexity, it is not enough to focus on physical bodily motion within the kinesphere but also to the inner movements of the body. If the kinesphere is the lived space that can be reached easily by extended limbs, *innesphere* concerns the internal space that can be reached under the skin. The skin should not be understood as a boundary between the kinesphere and the innesphere but rather as an interface that binds together inner bodily feelings and outer perception. The term “body image” aims to capture the internal and intimate feelings of one’s own body, but it emphasizes too much the visual and psychological aspects of embodiment. The notions of “body awareness” (Mehling et al., 2011) or “body topology” (Foster, 1997) are more helpful in understanding what is meant here by the dynamics of innesphere as a lived space. Body topography emphasizes the spatial character of the body as a lived space that describes internally felt body parts and spots and relations as a moving structure. Thus, movements within the body topography and innesphere do not just simply refer to bodily functions such as heartbeats or breathing, but how we *feel* them. Individuals usually locate the feeling of pain somewhere in their body topography, identifying its sensuous dynamism with terms like sharp, sore, itchy, stabbing, burning, stiff, stinging, tender, thumping, or tight. Feeling bodily sensations, as examples of movements within the innesphere, can also be imaginary and socially loaded. If meaning movements within the body topography can be imaginary or partly culturally constructed, then wearable technologies can hardly track them.

Therefore, wearable technologies cannot track sensations, feelings, and movements within the body topography in a manner that makes immediate sense and intuitive understanding.

Wearables and sensors track functions of the physical body, such as pulse, steps taken, or blood pressure, and turn these data into numerical or graphic forms based on their algorithms. So, what people are actually doing is reading on the screen the numerical data of their body functions but not really feeling their movements and sensations. Thus, these devices cannot capture the sensuous feelings of the lived body and its dynamics in the innesphere. Next, this analysis moves on to consider how the notion of choreography can assist in examining the movements of biomonitoring. The aim is to describe how biomonitoring takes place within one’s kinesphere as a microlevel choreography.

CHECKING LOOP AS MICROLEVEL CHOREOGRAPHY

In self-tracking physical performance, people usually glance at the device’s display from time to time to check on the data on body functions. Nagamura (2015) suggested that the action of looking at a mobile phone display has become increasingly universal. Users may look at their mobile phone displays with strong intent even when this action is nonessential. Research has indicated that some users intentionally look at their mobile phone displays to avoid unwanted conversation or hide themselves behind devices in public places (see, e.g., Baron & Campbell, 2012; de Souza e Silva & Frith, 2012). Nagamura (2015) argued that the action of looking at a mobile phone display as a social gesture should be regarded as performative behavior. Whether looking at a mobile phone display is an intentional or unintentional gesture, this simple action can be also considered as a kind of microlevel choreography.

In the act of looking at a mobile phone display, as a microlevel choreography, the user’s movement is restricted in turning the head and eyes towards the screen. Typically, this choreography consists of sequences of checking received messages or other information on the mobile. These checking sequences can be short or long, depending on how often the user handles his or her phone. The action of looking at a mobile phone display can become a harmful and compulsive behavior for users when it starts disturbing their essential daily activities (Roberts, Yaya, Honore, & Manolis, 2014).

As Nagamura (2015) stated, the mobile phone is considered an insensitive and forcible media because, even without any external calling, it keeps the user in a checking loop. Similarly, in terms of wearable technologies, users, such as runners, tend to look at these displays to check the informatics about their physical condition. In terms of fitness trackers, this choreography consists of sequences of checking informatics to which runners can respond by their physical activities, such as slowing down or speeding up, in following their fitness program in the correct way. This microlevel choreography might limit social interactions with other people in that the checking loop holds runners within their own private bubbles. Even if they might be running with others and transiting between places, they are concentrating on their own performance and controlling it within the checking loop.

Of course, the design of tracking devices is intended to provide information without being overly disruptive to the user. Users need only to glance quickly at their heart rate during their exercise. However, the data of biosensors orient the intentions of users during their workout. In monitoring the data, users actually ignore or bracket their feelings and sensations on body topography and other people within their kinesphere while concentrating strictly on the informatics of the physical body and its conditions. In this sense, the body is totally reduced to the numerical and graphic informatics on the display. The success of QS movement shows that monitoring the data of the pure physical body and its conditions frames people's everyday activities in a new manner. To reach the limit of 10,000 steps per day, people sometimes walk in place during their favorite television show. Nutrition blogger Scott Mowbray (2013) stated that, as soon as he puts his UP band on, he becomes, as he titled a blog post, "obsessed with walking 10,000 steps a day." He described how his tracker made him a "puppy," a "baby," or a "Boy Scout" when it comes to its feedback and control system. Even if most people see this as a positive development in motivating them toward a daily workout, trackers more or less keep them in a technological loop. In this sense, numerical and graphic data play a central role in what kind of interactions with digital devices people consider meaningful, motivating, and immersive during physical exercise. To understand both perspectives of biomonitoring—individual (micro) and infrastructural (macro)—I proceed to discuss how big data constitutes the opposite end of this feedback system.

BIG DATA AND MACROLEVEL CHOREOGRAPHY

Big data is often defined as data sets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze (Manyika et al., 2011). In 2011, that amount of data was produced every 2 days; by 2013, that much was generated every 10 minutes (Ajana, 2015). Although emphasis is often placed on the size aspect, it is worth recognizing that big data is by no means solely about large data sets. In fact, big data is, above all, networked relational data (Ajana, 2015; Manovich, 2012). The size is certainly an important characteristic on its own, but the power of connecting, creating, and/or unlocking patterns, as well as visualizing relations, is what makes big data such a seductive field for investment.

In using wearable devices, individuals and their physical bodies are measured by proprietary algorithms that track various aspects of their actions and movements. Wearable devices not only track and collect data on customers but more and more guide and influence customers' activities, such as fitness routines, sleep patterns, and food consumption. When biosensors monitor how long an individual has been immobile, the apps installed on the device may encourage him/her to walk around at specified intervals. Or when a person is walking along the street, the device can provide automated "fitness nudges," such as stating, "You're near the park. Why not go for a run?" This also implies that embodied agency and free will become increasingly mediated by algorithms in a manner where actions are no longer intentional. As wearable devices reshape perceptions of the body and of movement, the way people act in the world becomes increasingly shaped by the algorithms that govern those devices (Budish, 2015). The more seamless the experiences with wearables individuals have and the more they rely on them to interpret their bodies, the harder it is to know when those devices do not work as intended.

Companies and governments often promote the illusion that algorithmic processes and data-driven systems have been purged of human bias, errors, and interference, leading to more neutral, objective, and automated decisions (Ajana, 2015; Muller, 2004). However, classification systems are neither neutral nor objective but are biased toward their purposes. According to Dwork and Mulligan (2013), the level of big data brings ubiquitous classification that demands greater attention to the values embedded and reflected in the classifications and roles these classifications play in shaping public and private life. Data collected through devices can be saved and later analyzed, opening up the potential for profiling and surveillance.

Nissenbaum (2009) highlighted that understanding privacy violations is often linked to who has power in the relationship and who is benefiting from an arrangement. Activity trackers and wearables are seen as powerful self-motivational tools, but what if they become mandated by employers to reduce sick days? As Olson (2014) pointed out, some employers have considered punishments for unhealthy behavior recorded by wearables. For example, the data used by an individual to meet personal goals and shared with health care providers to provide a more accurate diagnosis can also be shared with insurance companies to help maximize profits. Many of the privacy issues with wearables indicate that the data gathered by wearables may not be securely stored. Moreover, there are some indications that the current generation of models in this industry has not been designed with security as a priority. A recently released report noted that applications related to the QS frequently have not implemented even basic data encryption (Barcena et al., 2014.)

Very often, big data is seen as immaterial or disembodied, as separated from the physical bodies (*Körper*) and lived bodies (*Leib*). The danger in these perceptions is that such attitudes underestimate political and ethical consequences when addressing the implications of big data on identity, embodiment, and agency. To understand the dynamic among big data, the algorithms of sensors, and embodiment, it is necessary to turn again to the notion of choreography. In terms of wearable devices, microlevel choreography consists of the sequences of checking informatics to which users respond by their physical activities, to follow their fitness program in more or less obedient manners. In the checking loop of microlevel choreography, users generate not only data about the condition of their physical bodies but also about their intentions to follow, or not, the guidance and suggestions of fitness trackers. Even if fitness trackers and wearables cannot monitor the feelings of lived bodies, there are apps, such as MoodTracker, that persuade people to estimate and state their own feelings, moods, and emotions during and after their physical exercise. Manufacturers are interested in designing wearable devices that are more immersive and more pervasive in data collection. Big data is needed to develop further the algorithms for devices that can give more sophisticated suggestions for customers (Harwood, 2014). As the algorithms of wearables continue to advance, they become more adept at recognizing individual and collective patterns of behavior and, as a result, become more seamless extensions of the users' bodies (Charara, 2015).

As stated above in terms of HDI, people interact regularly with mundane and embodied knowledge infrastructures that they do not necessarily understand or even recognize. In this infrastructure, digital technologies, action, and materiality intertwine; bodies become actants of larger assemblage technologies and objects. Latour (1997) suggested that bodies do not just participate in these networks, but bodies are actively shaped by them, developing new habituation and embodied practices. A checking loop as a microlevel choreography can be considered an embodied practice that stabilizes and reproduces a network of biomonitoring while assisting the circulation of personal data. Personal information generated from individual microlevel choreographies constitutes big data as an opposite end of this process. These two opposites are not combined together in an arbitrary manner, but they include complex feedback systems. Even if the feedback system—from big data back towards individuals—can remain obscure and is delayed, it does not mean that feedback would not exist. The feedback system can be seen, for instance, in the manners of how employers first motivate and then later push employees to use fitness trackers to reduce their health care costs. Latour's vision can assist in understanding the feedback system as a network or as choreography rather than a simple mechanistic input–output system. Following Wittgenstein's metaphor, Latour (1997) recommended considering how a rope is made of many strings; numerous weak and short strings are intertwined together to form one strong rope. Moreover, it is not necessary that one string serves as the core throughout the rope's entire length. Translating that point into the case of embodied practices, when more and more people are involved in the checking loop as part of their everyday microchoreography, it becomes gradually a commonplace behavior that turns into a powerful norm to follow.

In this sense, moving bodies, monitoring their health informatics on the screen, can be seen to be involved in a much bigger loop beyond just a simple, personal, and intimate checking loop. This big loop concerns feedback systems that are built from the big data of health informatics and sent back towards customers. For instance, as Thomaz (2013, p. 3) suspected, "This emerging type of self-tracking data has become the basis of a participatory health movement where the axis of responsibility in healthcare shifts more towards individuals and away from institutions." This implies that people should take a much larger responsibility for their own health (Lupton, 2013). In this new landscape, self-tracking would become the norm, and people would be responsible for monitoring any symptoms of diabetes or cancer in their physical bodies. These types of reward-and-sanction systems can be developed to sustain the self-governance of individuals. Constructing profiles of individuals and groups in terms of their physical conditions could be used intentionally to diminish a person's range of future options and to allow or disallow a person to act in a certain way (Kerr & Earle, 2013). These feedback systems in biomonitoring from big data back towards individuals have only started to emerge, so it is still too early to speculate what kind of new norms and embodied practices this choreography can evolve toward in the near future.

DISCUSSION

The number of people adhering to biomonitoring and self-tracking is growing very quickly. If a mainstream participatory medicine movement materializes, as Lupton (2013) and Thomaz (2013) proposed, certain societal, health-focused expectations and behavior patterns with regards to self-tracking will be established. Self-tracking data bring to the foreground a new level of quantifiable health parameters that, in the long-run, could become new sources of health routines. These transformative patterns and expectations could be liberating, but they also might result in undesirable outcomes. In this paper, my aim has been to show that a choreography-based approach to biomonitoring can open up a new proactive perspective to understand feedback systems from the stream of big data towards everyday individual behavior. In this way, this chosen approach can make more visible how individual adaptions of new technologies entwine with the institutional level to affect the policy of health care systems in the long-run.

It seems, paradoxically, that the more individuals pursue goals of subjective choices, such as biomonitoring, the more frantically they build a world in which the means and ends are dislocated, resulting in a circular dynamic that only accelerates the processes of technological proliferation (Davison, 2004). I reiterate here that if analysis remains focused only on the microlevel dimensions of embodied experiences, it fails to cover the political and economic consequences of technological ensembles and their functions. To avoid the collapse of discussion about HCI into approaches that emphasize embodied cognition and subjective experiences, this choreographic methodology aims at illuminating intimate embodied experiences in the context of a large-scale data-processing system with political and economic interests behind it.

The analysis presented in this paper has shown how a microchoreography model of a checking loop can actually reduce individuals' chances of getting involved with instant experiences of lived bodies and social interaction with other lived bodies. One important aspect of biomonitoring as an everyday activity is that it brings forth an entirely new type of "instrumentalization" towards embodiment. The instrumentalization of the body refers to how people treat their bodies as external "test objects" by conducting various types of experiments as part of QS projects. This may lead to many difficulties, some of which have already been discussed in the literature (e.g., Kaptelinin & Nardi, 2006; Khovanskaya et al., 2013; Lupton, 2013; Sanches, Kosmack Vaara, Sjölinder, Weymann, & Höök, 2010; Thomaz, 2013). One of the consequences is that people's contact with lived bodies is constantly mediated via digital tools and sensors, and thus individuals can lose the capability to understand and trust the direct sensual information from their bodies. Inevitably, lived bodies and body awareness are disappearing behind numerical data of devices. Scholars (e.g., Khovanskaya et al., 2013) have concerns about whether these interfaces of personal health informatics enable long-term behavior change or simply narrow the definition of healthiness to easily quantifiable metrics. One relevant question to consider is how easily biomonitoring develops compulsive behavior in users who may have tendency to develop, for instance, *orthorexia nervosa*, a fixation on righteous eating.

Interestingly, fitness trackers are a highly intimate, personal technology, yet, in a way, they distance people from their lived bodies to collect and store personal data about their physical bodies. And as this analysis has suggested, perhaps various tools, based on big data outputs, can be developed for new control systems for behavior in the future. When the user's intentionality is focused on monitoring the fitness tracker, this activity simultaneously assists in alternative ways to process big data. Following the notion of HDI, embodied interaction design should not be exclusively fixed on studying user–device relations or toward any specific contextual circumstances of use. Instead, the primary starting point should be set to the streams and traces of big data and their connections to the affective microchoreographies of users. From this stance, devices are not accounted for in terms of how they influence immediate embodied activities but in what kind of invisible loop users are immersed at the institutional level.

When direct interaction with the environment and other people decreases and becomes more mediated via digital devices, this might move individuals towards more abstract, information-based, and cognitive-driven activities. In this context, actions are often seen as a means to input information to a device so that it could output or perform something for people. When people increasingly value exact information on their physicality—at the expense of their lived bodies and affective connections with other people—they are also in danger of ultimately weakening the very abilities to appreciate their own intuition and judgment.

IMPLICATIONS FOR THE THEORY OF INTERACTION DESIGN

The implications for theory of interaction design created by this article concern a new choreography-based analysis method that can capture movement as a reciprocal and dynamic matrix between humans and technology. In bringing together phenomenological methodology and Latour's actor–network theory, choreography is seen to arise from the relations of actants and becomes perceptible through movements, motion, patterns, and rhythms. Discussions of the choreographic matrix between the intimate act of biomonitoring and the generation of big data can concretize how human interaction with objects reaches beyond immanent embodied experiences. However, in this assemblage, embodied connections with digital technologies modify physical and lived bodies, forming new kinds of embodied practices and policies. This choreography-based approach can capture feedback systems—not just in how biomonitoring generates big data, but also in how the streams of big data turn back towards consumers and citizens. This approach can make more visible why personal data is not solely a personal issue and how big data is involved in embodiment and agency.

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